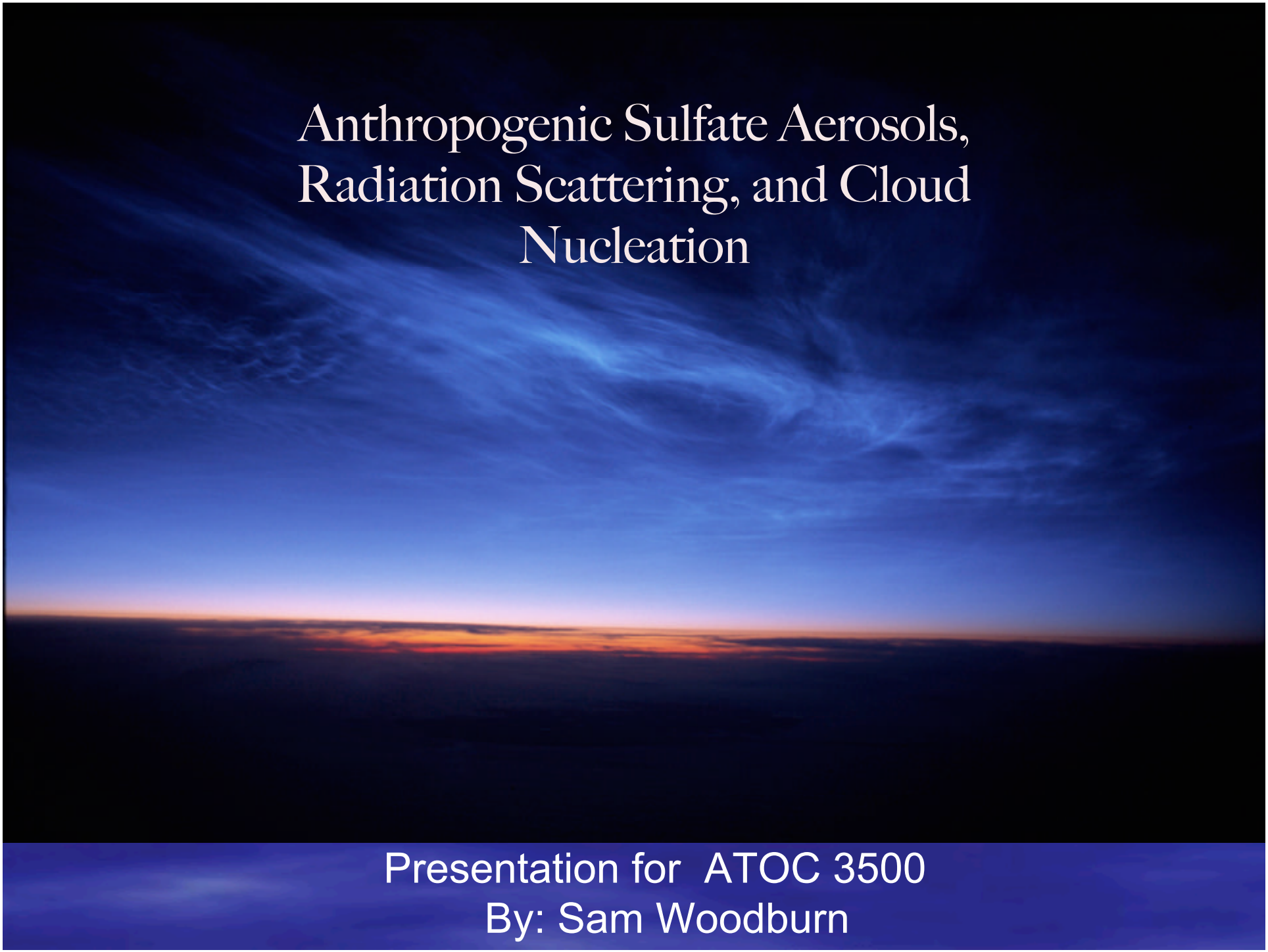


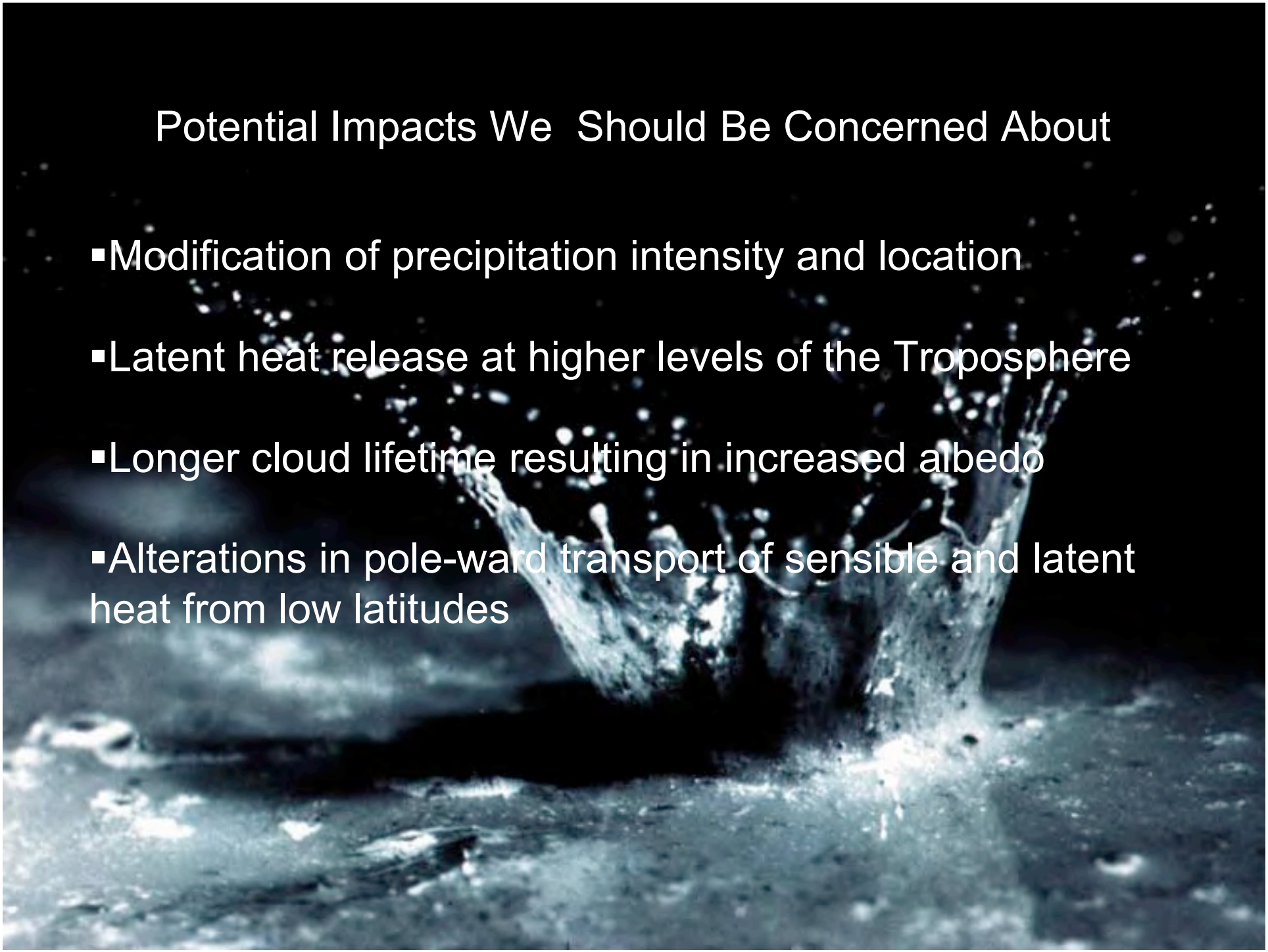
Anthropogenic Sulfate Aerosols, Radiation Scattering, and Cloud Nucleation

Presentation for ATOC 3500

By: Sam Woodburn

Background

- Sulfate aerosols in the Troposphere at low latitudes result in increased concentrations of cloud condensation nuclei necessary for precipitation
- This results in the reduction of cloud droplet size, alterations in cloud optical properties, and forcing precipitation to take place at higher elevations through ice processes
- The primary anthropogenic sources include automobiles, coal-fired power plants, and burning of biomass

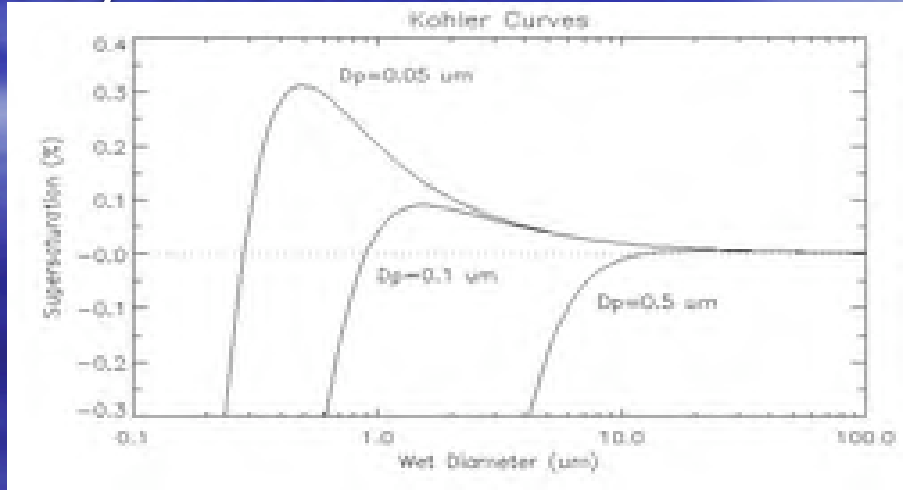


Potential Impacts We Should Be Concerned About

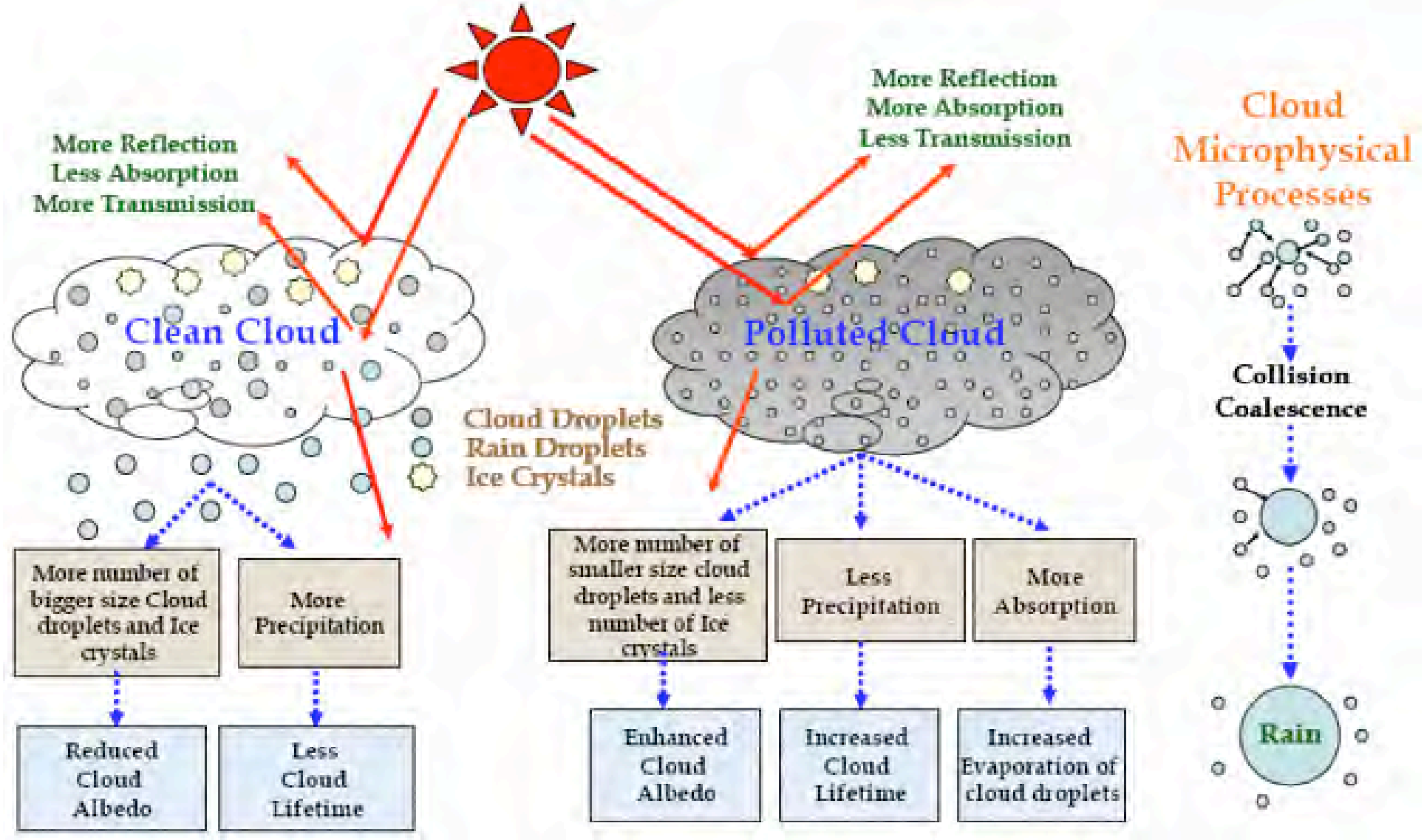
- Modification of precipitation intensity and location
- Latent heat release at higher levels of the Troposphere
- Longer cloud lifetime resulting in increased albedo
- Alterations in pole-ward transport of sensible and latent heat from low latitudes

The Nucleation Process

- Surface-based aerosols become entrained in vertical transport mechanisms such as convection or through vacuum-like kinetic regime if particles are sufficiently small
- Particle growth takes place through, homogenous nucleation, heterogenous nucleation, and agglomeration
- Condensation nucleus sort by size which dictates their ability to become supersaturated as seen by Kohler curve

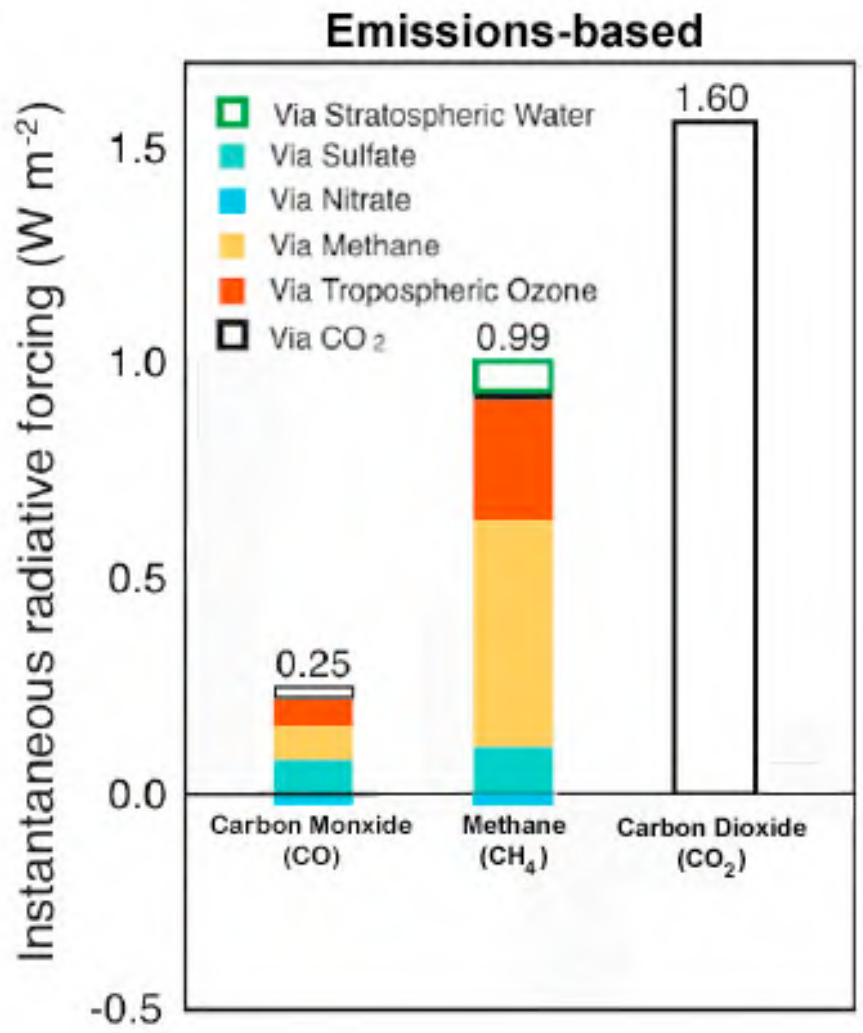


Aerosol Scavenging Processes



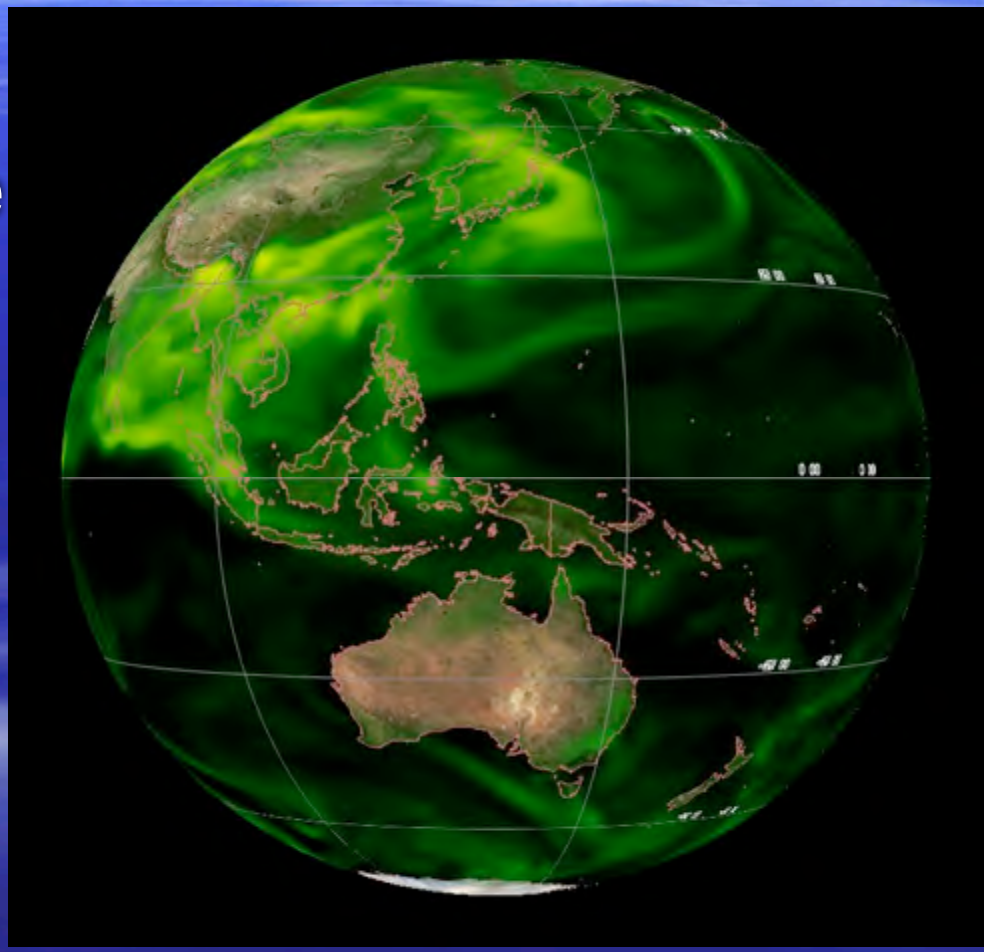
Cloud Drops and Radiation Absorption

- Supersaturation of CCD results in less available moisture for cloud drop growth
- As a result cloud water path longer and cloud albedo increases due to decrease in size of cloud drops



Increased Cloud Lifetime

- Reduced cloud drop size and increase in mean free path results in longer cloud lifetime and more strato-cirrus like cloud types



http://sos.noaa.gov/videos/sulfate1.mov

Climate Feedbacks

- Increased albedo and cloud cover results in decreased solar radiation at the surface slowing hydrologic cycle
- However impacts may be localized due to spatial variability of sulfate aerosols
- http://www.vets.ucar.edu/vg/RaschSulfate/movies/rasch_iso.mpg

- Reduced size of cloud particles supresses precipitation and can increase cloud coverage and lifetime
- Increased scattering of incoming radiation leads to potential cooling.

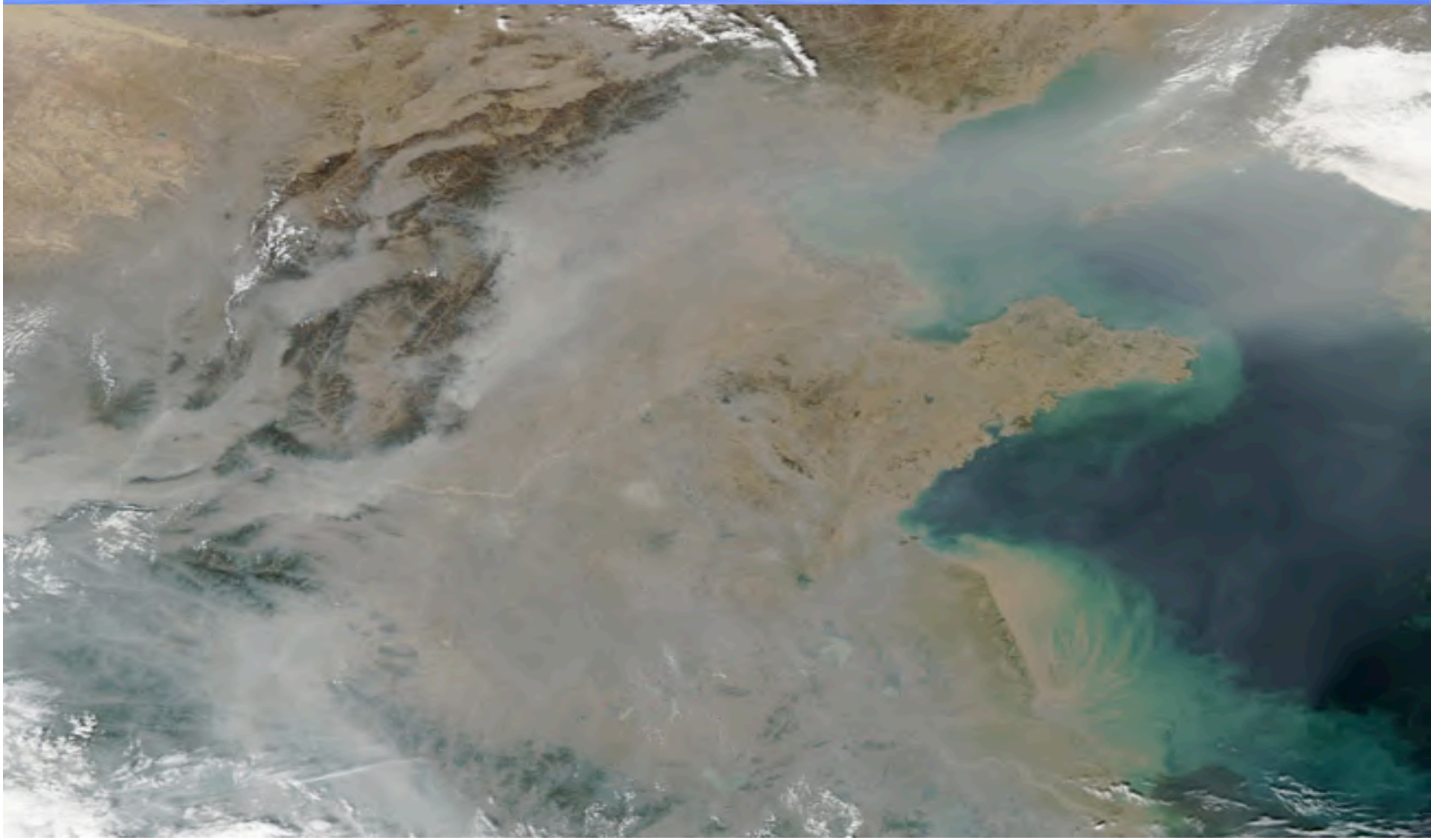
Accuracy Issues/Controversy

- Sulfate Aerosols often have some water attached so it's is difficult to determine climate forcings
- These forcings are with respect to sulfate aerosols
- The idea of global dimming sulfate aerosols generally show negitive radiative forcing
- However many other aerosols with positive forcing
- Depends on microphysical sources and sinks of cloud droplets and ice crystals (soot nuclei promote glaciation, more precipitation locally)

Models Exhibit Variability

- http://www.ccsm.ucar.edu/models/atm-cam/docs/description/node26.html

Example of Luminescent Sulfate Aerosol Cloud



Questions?

Sources

http://www.ccsm.ucar.edu/models/atm-cam/docs/description/node26.html

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http://www.vets.ucar.edu/vg/RaschSulfate/index.shtml